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(54) **HOUSING APPARATUS FOR HEAT GENERATING DEVICE**

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See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

3,120,166	A *	2/1964	Lyman	.....	454/307
3,210,456	A *	10/1965	Skubal	.....	174/16.1
4,644,095	A *	2/1987	Bright et al.	.....	174/50
4,665,654	A *	5/1987	Stedron et al.	.....	49/484.1
4,753,496	A *	6/1988	Bussard	.....	312/236
5,150,277	A *	9/1992	Bainbridge et al.	.....	361/695
5,428,503	A *	6/1995	Matsushima et al.	.....	361/695
5,460,441	A *	10/1995	Hastings et al.	.....	312/298
5,467,250	A *	11/1995	Howard et al.	.....	361/696

5,544,012	A *	8/1996	Koike	.....	361/695
5,608,609	A *	3/1997	Morrell	.....	361/690
5,798,485	A *	8/1998	Rohde et al.	.....	174/383
5,851,143	A *	12/1998	Hamid	.....	454/57
5,949,646	A *	9/1999	Lee et al.	.....	361/695

(Continued)

**FOREIGN PATENT DOCUMENTS**

CN 1392768 A 1/2003  
(Continued)

**OTHER PUBLICATIONS**

“Notification of the First Office Action” mailed by the Chinese Patent Office on Jun. 5, 2009, for Chinese Patent Application No. 200710084469.8.

(Continued)

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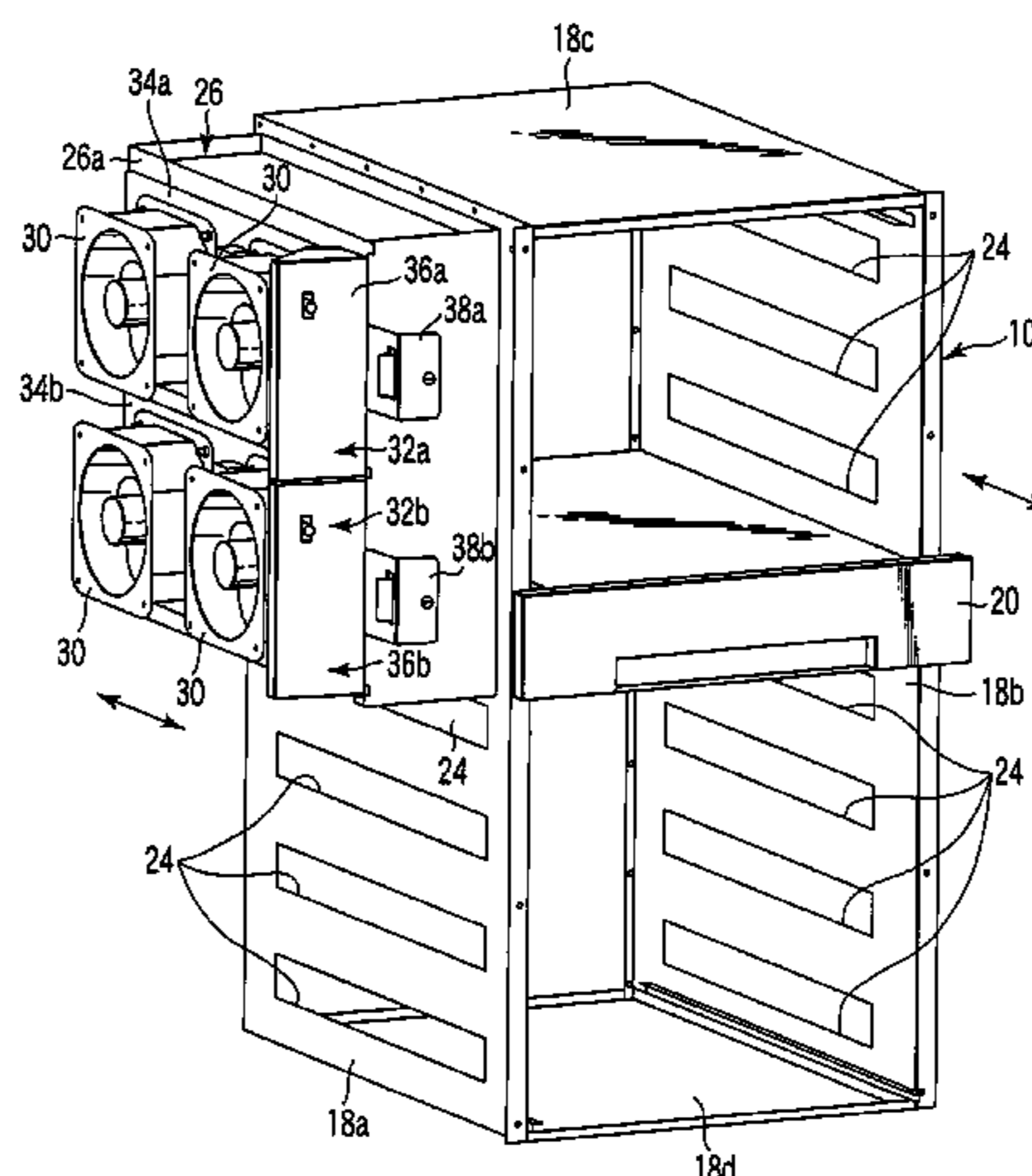
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(57) **ABSTRACT**

According to one embodiment, a housing apparatus for a heat generating device includes a housing being provided with sidewalls arranged sideward to separate from each other, and shelf members placed at a plurality of positions along the sidewalls between the sidewalls. The shelf members support a plurality of devices including a heat generating device, and each sidewall has a plurality of ventilation openings corresponding to the devices held by the shelf members. A duct member is provided on at least outermost sidewall to correspond to at least two adjacent ventilation openings in the outermost sidewall. An airflow producing unit is provided in the duct member and includes at least two airflow producing devices performing one of supplying outside air into the inside of the housing and evacuating the inside air from the housing through the at least two adjacent ventilation openings.

**6 Claims, 5 Drawing Sheets**



# US 8,096,861 B2

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## U.S. PATENT DOCUMENTS

6,088,225	A *	7/2000	Parry et al. ....	361/704
6,104,003	A *	8/2000	Jones .....	219/400
6,164,369	A *	12/2000	Stoller .....	165/104.33
6,186,890	B1 *	2/2001	French et al. ....	454/184
6,198,628	B1 *	3/2001	Smith .....	361/695
6,294,762	B1 *	9/2001	Faries et al. ....	219/400
6,309,296	B1 *	10/2001	Schwenk et al. ....	454/184
6,351,381	B1	2/2002	Bilski et al.	
6,554,697	B1 *	4/2003	Koplin .....	454/184
6,603,660	B1 *	8/2003	Ehn et al. ....	361/694
6,652,374	B2 *	11/2003	Sharp et al. ....	454/184
6,657,861	B2 *	12/2003	Irmer .....	361/695
6,742,583	B2 *	6/2004	Tikka .....	165/291
6,788,535	B2 *	9/2004	Dodgen et al. ....	361/695
6,807,056	B2 *	10/2004	Kondo et al. ....	361/689
6,833,991	B2 *	12/2004	Van Gaal .....	361/690
6,847,013	B2 *	1/2005	Audette et al. ....	219/400
2003/0124970	A1 *	7/2003	Webster et al. ....	454/184
2006/0256541	A1 *	11/2006	Sandgren et al. ....	361/796

## FOREIGN PATENT DOCUMENTS

JP	10-13071	1/1998
JP	2001-094281	4/2001
JP	2001-244676	9/2001
JP	2002-026572	1/2002
JP	2004-179518	6/2004
JP	2004-363236	12/2004
JP	2005-072960	3/2005
WO	WO 03/001861 A1	1/2003

## OTHER PUBLICATIONS

“Notification of Reasons for Rejection” mailed by the Japanese Patent Office on Sep. 24, 2008 for Japanese Patent Application No. 2006-064792.

\* cited by examiner

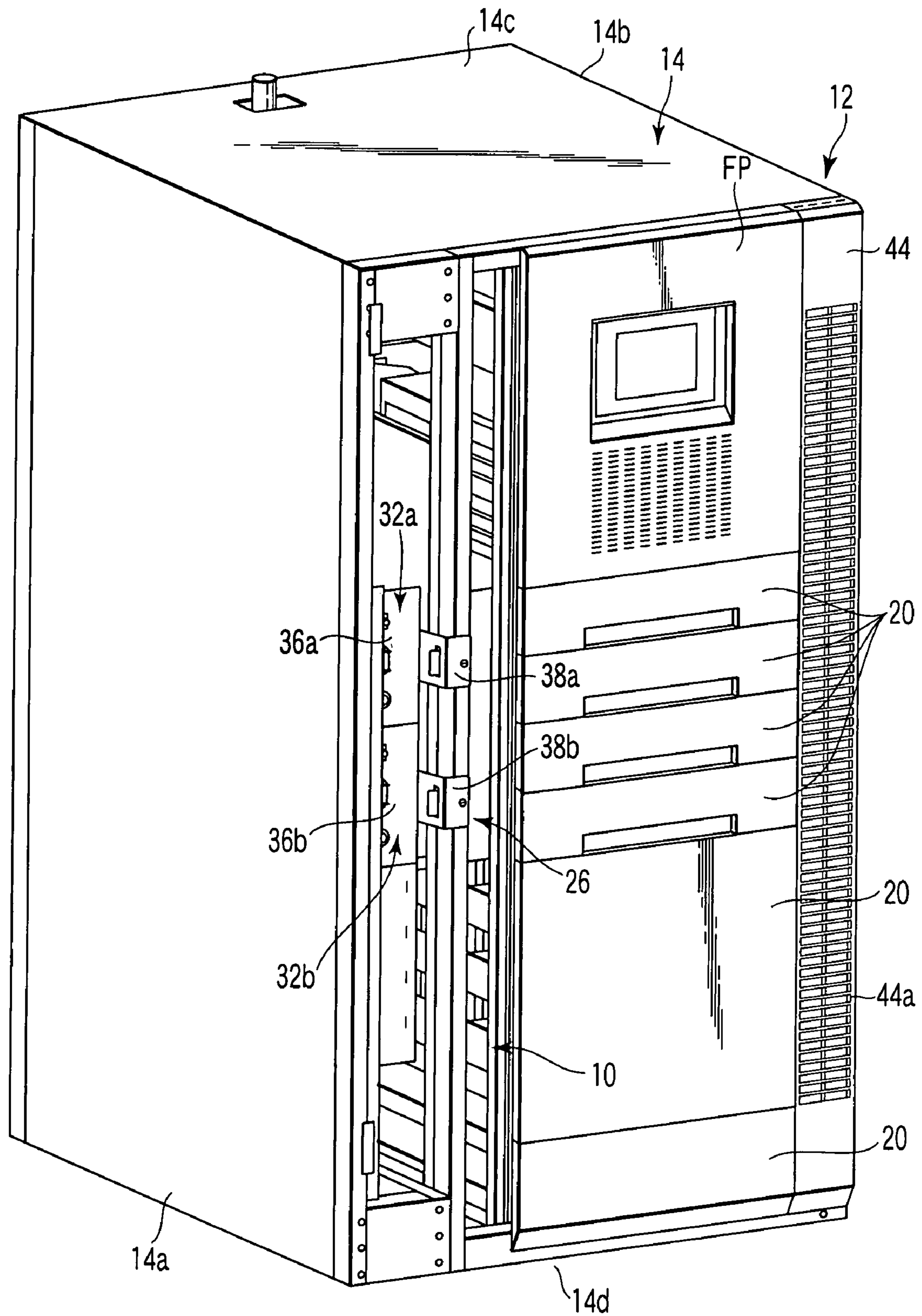


FIG. 1

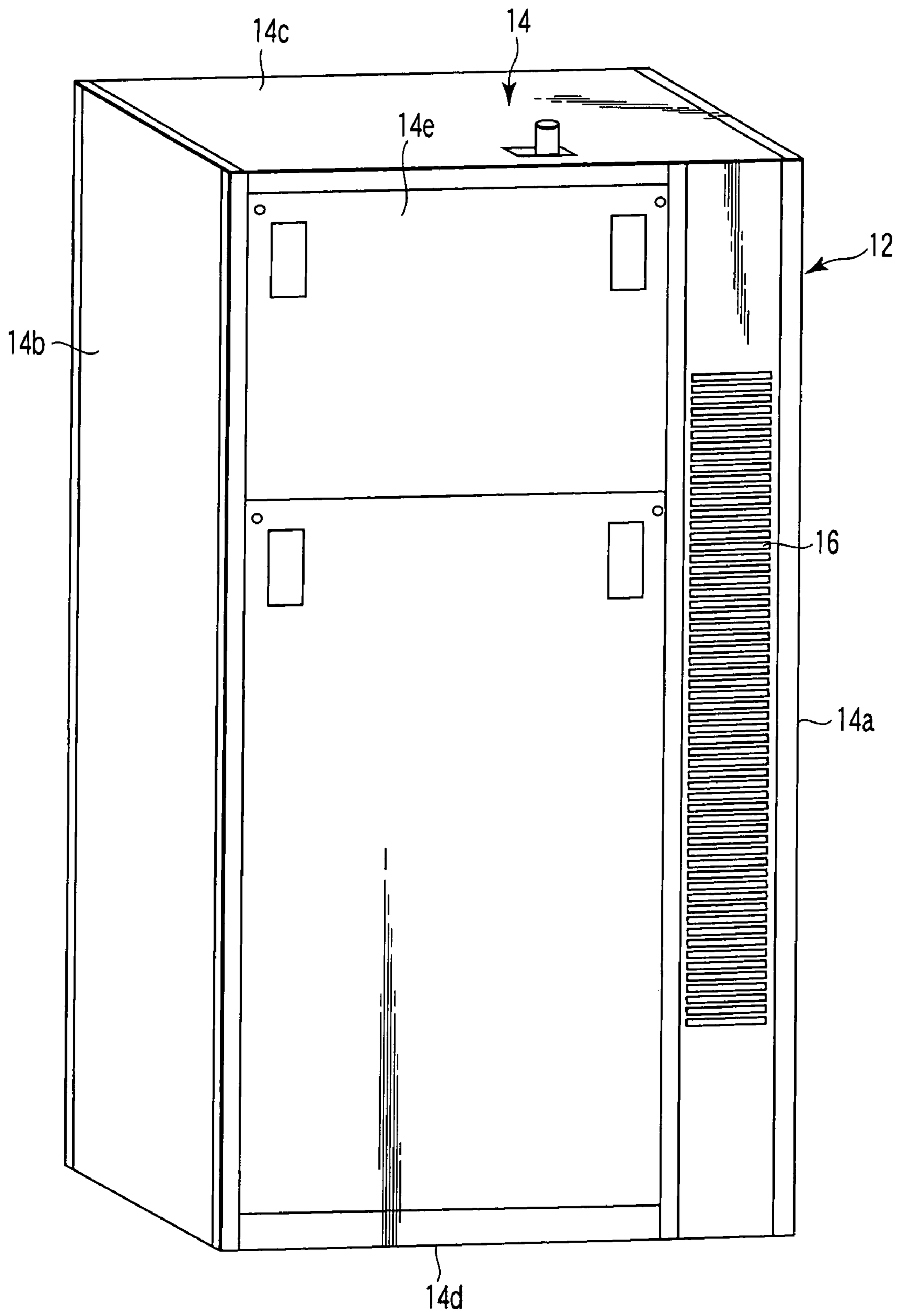


FIG. 2

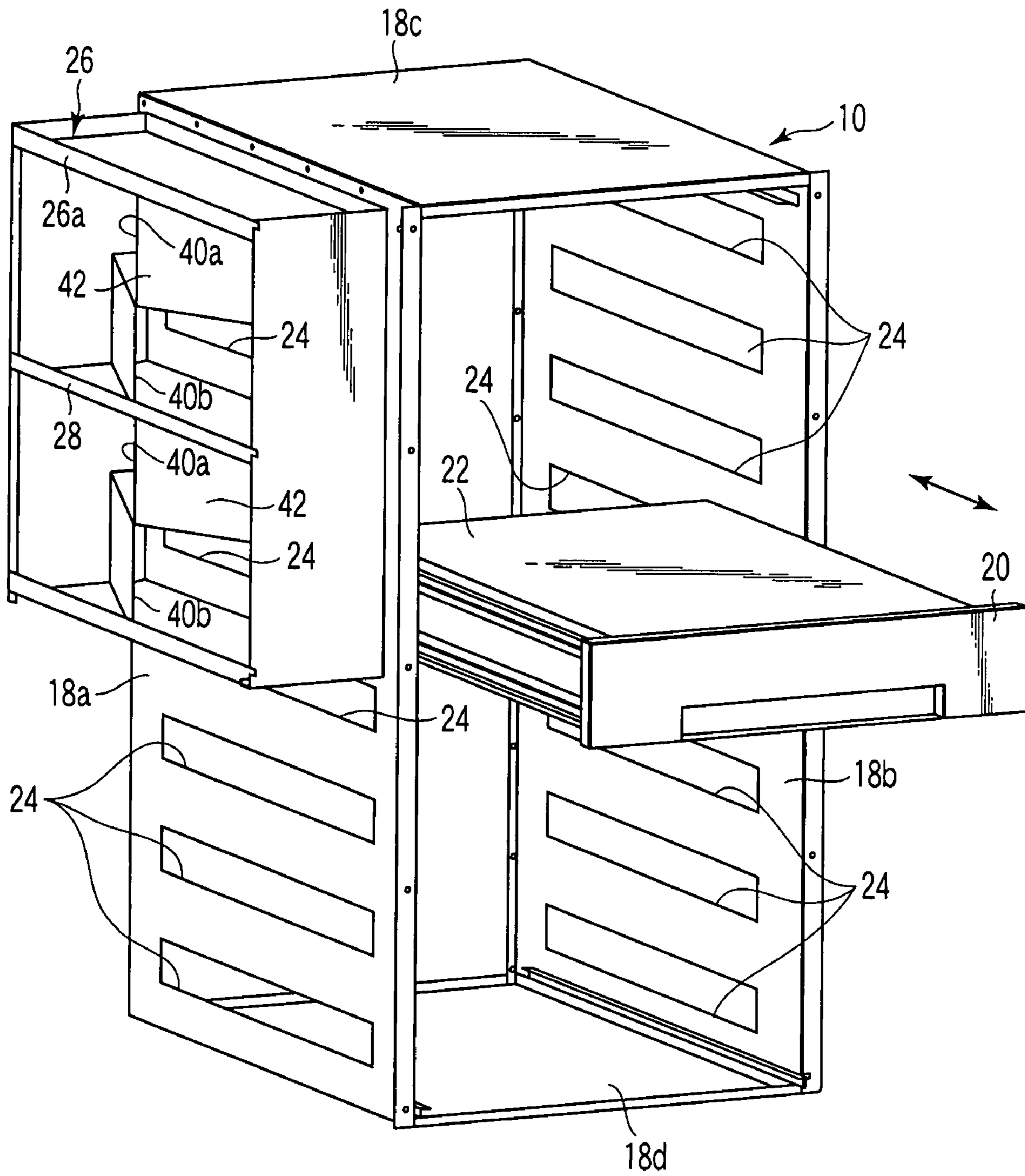


FIG. 3

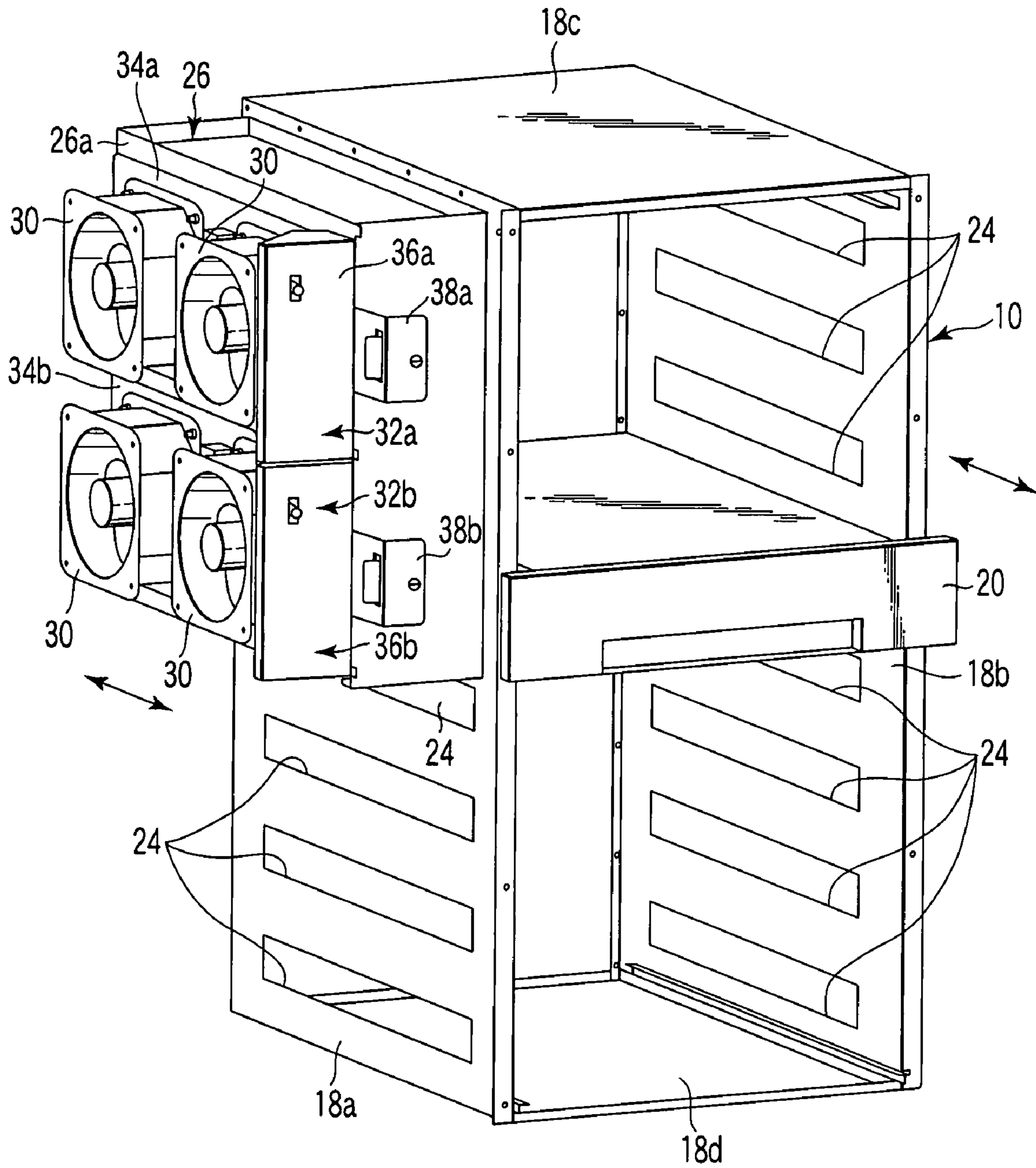


FIG. 4

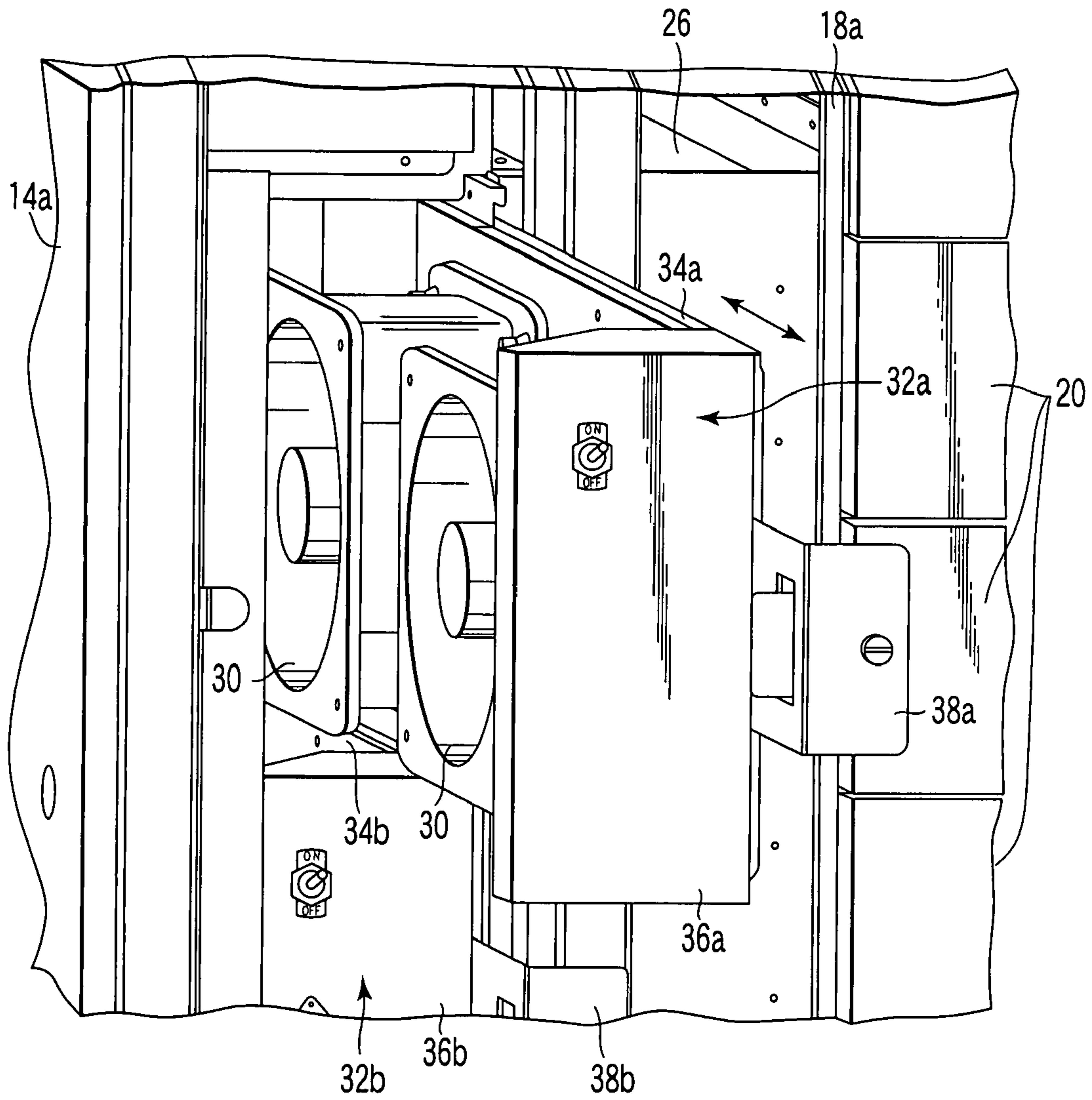


FIG. 5

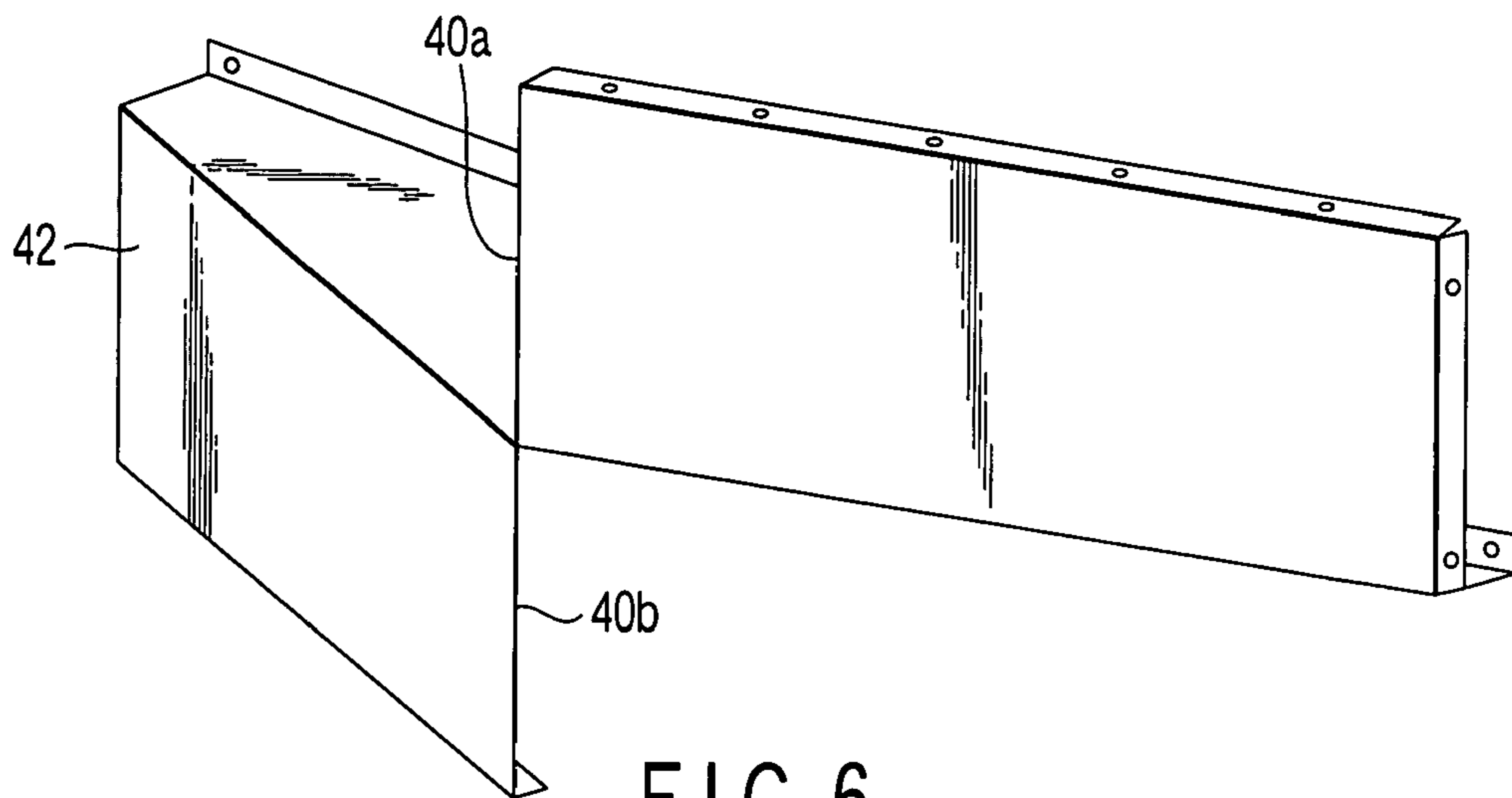


FIG. 6

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## HOUSING APPARATUS FOR HEAT GENERATING DEVICE

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2006-064792, filed Mar. 9, 2006, the entire contents of which are incorporated herein by reference.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

One embodiment of this invention relates to a housing apparatus for a heat generating device.

#### 2. Description of the Related Art

Various heat generating devices such as an amplifier are used in a field of electrical communication. These heat generating devices including the amplifier are arranged to separate from each other in a housing apparatus. A plurality of ventilation openings is formed in the housing apparatus, and a blower and/or an evacuating device are or is provided in the housing apparatus.

The blower supplies outside air into the housing apparatus, and forces air heated by the heat generating devices in the housing apparatus to the outside through the ventilation openings. The evacuating device evacuates air heated by the heat generating devices in the housing apparatus to the outside through the ventilation openings.

Such a conventional housing apparatus for a heat generating device as described above has been well known by Jpn. Pat. Appln. KOKAI Publication Nos. 2004-179518 and 10-13071, for example.

The Jpn. Pat. Appln. KOKAI Publication No. 2004-179518 discloses a housing apparatus in which substrates including a heating circuit are housed in stand up positions to be separated from each other. An upper end of the housing apparatus is opened upward, and the upper end opening of the housing apparatus is covered by a cover provided with an evacuating fan.

The Jpn. Pat. Appln. KOKAI Publication No. 10-13071 discloses a housing apparatus including a pair of sidewalls and a plurality of shelves arranged between the sidewalls to be separated from each other in the vertical direction. Various devices including a heat generating device are placed on the shelves. Ventilation openings are formed in each sidewall at a plurality of positions corresponding to the devices placed on the shelves. A blower fan is arranged on the outside of one sidewall and supplies outside air into the housing apparatus through the ventilation openings of the one sidewall. The ventilation openings can be selectively closed by a shield plate, so that the only ventilation openings corresponding to the heat generating device which especially needs cooling have been opened.

### BRIEF SUMMARY OF THE INVENTION

According to one embodiment, a housing apparatus for a heat generating device includes a housing including a plurality of sidewalls arranged sideward to separate from each other, and a plurality of shelf members placed at a plurality of positions along the sidewalls between the sidewalls. The shelf members support a plurality of devices including a heat generating device, and each sidewall has a plurality of ventilation openings corresponding to the devices held by the shelf members. A duct member is provided on at least one outermost

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sidewall of the sidewalls of the housing and corresponds to at least two adjacent ventilation openings of the ventilation openings in the at least one outermost sidewall. The duct member includes an airflow guide plate providing at least two airflow guide paths corresponding to the at least two ventilation openings. An airflow producing unit is provided in the duct member. The airflow producing unit includes at least two airflow producing devices performing one of supplying outside air into the inside of the housing and evacuating the inside air from the housing through the at least two adjacent ventilation openings corresponding thereto. The at least two airflow producing devices of the airflow producing unit are arranged so that one of the at least two airflow producing devices is in front of the other along the at least one outermost sidewall. Each airflow producing device faces the at least two adjacent ventilation openings corresponding thereto. The at least two airflow producing devices perform one of supplying outside air to the inside of the housing and evacuating the inside air from the housing through the at least two airflow guide oaths.

### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate a presently embodiment of the invention, and together with the general description given above and the detailed description of the embodiment given below, serve to explain the principles of the invention.

FIG. 1 is an exemplary perspective view showing a front side of a housing apparatus for a heat generating device according to an embodiment of this invention;

FIG. 2 is an exemplary perspective view showing a rear side of the housing apparatus for a heat generating device of FIG. 1;

FIG. 3 is an exemplary perspective view showing a main framework of a housing of the housing apparatus for a heat generating device of FIG. 1, together with a duct member for attaching a fan unit fixed to the framework;

FIG. 4 is an exemplary perspective view showing the framework of FIG. 3, in a state that a fan unit is attached to the duct member for attaching a fan unit;

FIG. 5 is an exemplary enlarged perspective view showing the fan unit and its surroundings of FIG. 4; and

FIG. 6 is an exemplary perspective view of an air guide plate provided in the duct member of FIG. 3.

### DETAILED DESCRIPTION OF THE INVENTION

A housing apparatus for a heat generating device according to an embodiment of the invention will be explained in detail hereinafter with reference to the accompanying drawings.

The housing apparatus for a heat generating device according to the embodiment of the invention houses devices which provides a transmitter of a communication device and which includes a heat generating device represented by an amplifier.

The housing apparatus for a heat generating device has a housing **12** including a framework **10**, as shown in FIG. 1 and FIG. 2. The housing **12** includes a rectangular outer case **14** surrounding the framework **10** and elongated in the vertical direction.

The outer case **14** includes a pair of vertically elongated rectangular outside panels **14a** and **14b** placed parallel to each other and spaced sideward from each other, a top panel **14c** covering a square upper opening between the pair of outside panels **14a** and **14b**, a bottom panel **14d** covering a square



lower opening between the pair of outside panels **14a** and **14b**, and a rear panel **14e** covering a vertically elongated rectangular rear opening between the pair of outside panels **14a** and **14b**. The rear panel **14e** is divided into a plurality of sections to facilitate maintenance of devices, members, etc. housed in the outer case **14**. And, a number of ventilation openings **16** are formed in a vertical section which is positioned on the right side when the outer case **14** is viewed from the rear, and which extends along the outside panel **14a** between the top panel **14c** and bottom panel **14d**.

The framework **10** includes a pair of sidewalls **18a** and **18b** placed parallel to each other and spaced sideward from each other, as shown in detail in FIG. 3. The upper ends of the sidewalls **18a** and **18b** are connected by an upper support member **18c**. The upper support member **18c** covers the upper square opening between the sidewalls **18a** and **18b**. The lower ends of the sidewalls **18a** and **18b** are connected by a lower support member **18d**. The lower support member **18d** covers the lower square opening between the sidewalls **18a** and **18b**.

A plurality of shelf members **20** are removably provided at a plurality of positions along the sidewalls **18a** and **18b** in a space surrounded by the sidewalls **18a** and **18b** and the upper and lower support members **18c** and **18d**. In this embodiment, each shelf member **20** is held by not-shown and well known guide rails to be movable in back and forth directions relative to the sidewalls **18a** and **18b** between a retracted position and a forward projected position, at the retracted position each shelf member **20** locating between sidewalls **18a** and **18b**, and at the forward projected position each shelf member **20** projecting forward from the sidewalls **18a** and **18b**. Each shelf member **20** can be selectively fixed at the retracted position by a not-shown fixing device.

Various devices **22** providing a transmitter of a communication device and including a heat generating device such as an amplifier are mounted on the shelf members **20**, and removably fixed by not-shown and well known removable fixing means.

A plurality of ventilation openings **24** are formed in each of the sidewalls **18a** and **18b** to corresponding to the devices **22** supported by the shelf members **20**. A duct member **26** having a rectangular cross section is provided on one of the sidewalls **18a** and **18b** to correspond to at least two, four in this embodiment, adjacent ventilating openings among the ventilating openings **24**. The duct member **26** has one end in which one opening facing one sidewall **18a** is formed and the other end in which the other opening opposing to the sidewall **18a** is formed. The inner space of the duct member **26** is divided by a partition wall **28** into two chambers each of which corresponding to two adjacent ventilation openings **24**.

The shelf members **20** corresponding to the four ventilation openings **24** corresponding to the duct member **27** supports the devices that produce a large amount of heat, for example an amplifier.

As shown in detail in FIG. 4, at least two, four in this embodiment, airflow producing devices **30** are provided on the other end of the duct member **26** to correspond to at least two, four in this embodiment, ventilation openings **24** to which the duct member **26** corresponds.

Four airflow producing devices **30** are classified into one airflow producing unit **32a** including two devices **30** corresponding to one chamber of the duct member **26**, and the other airflow producing unit **32b** including two remaining devices **30** corresponding to the other chamber of the duct member **26**.

Two airflow producing devices **30** of the one airflow producing unit **32a** are arranged in the back and forth directions of the corresponding sidewall **18a**, and are supported by a

common support panel **34a**. The support panel **34a** is held by a not-shown and well known guide rail provided at the outer end of the upper wall **26a** of the duct member **26** to be movable in the back and forth direction between a retracted position and a projecting forward position. At the retracted position the support panel **34a** is located on the side of the outer end of the upper wall **26a**, and at the projecting forward position the support panel **34a** projects forward from the side of the outer end of the upper wall **26a**.

Two airflow producing devices **30** of the other airflow producing unit **32b** are also arranged in the back and forth directions of the corresponding sidewall **18a**, and are supported by the other common support panel **34b**. The other support panel **34b** is held by a not-shown and well known guide rail provided at the outer end of the partition wall **28** of the duct member **26** to be movable in the back and forth direction between a retracted position and a projecting forward position. At the retracted position the other support panel **34b** is located on the side of the outer end of the partition wall **28**, and at the projecting forward position the other support panel **34b** projects forward from the side of the outer end of the partition wall **28**.

In this embodiment, each of the airflow producing devices **30** includes an axial fan.

The support panels **34a** and **34b** include front covers **36a** and **36b**, each of which is arranged at forward of the front and rear airflow producing devices **30**, and grips **38a** and **38b** projecting forward from the front covers **36a** and **36b**.

The duct member **26** further includes two airflow guide plates **42** arranged in two chambers. Each airflow guide plate **42** provides two airflow guide paths **40a** and **40b**, each corresponding to two ventilation openings in each of two chambers. In each chamber, the outer ends of two airflow guide paths **40a** and **40b** are opened toward two airflow producing devices **30** corresponding to each chamber of the duct member **26**. Also, in each chamber, the inner ends of two airflow guide paths **40a** and **40b** are opened toward two ventilation openings **24** corresponding to each chamber of the duct member **26**.

When the framework **10** provided with the duct member **26** and two airflow producing units **32a** and **32b** as shown in FIG. 4 is housed at a predetermined position in the inner space of the outer case **14**, the front panels of the shelf members **20** placed at the retracted positions cover the most of the middle part of the front opening of the outer case **14** as shown in FIG. 1, and two side spaces are produced between the pair of sidewalls **18a** and **18b** of the framework **10** and the pair of outside panels **14a** and **14b** of the outer case **14**.

In this embodiment, other various devices related to the devices supported by the shelf members **20** of the framework **10** are housed in the upper end portion of the middle part of the inner space in the outer case **14**, and a front panel FP for the other devices covers the remainder of the middle part of the front opening of the outer case **14**.

The duct member **26** provided with two airflow producing units **32a** and **32b** placed at the retracted positions is located in one side space area between one sidewall **18a** of the framework **10** and one outside panel **14a** of the outer case **14**. The front opening of the one side space area is covered with a not-shown first open/close cover attached to the front end of the one outside panel **14a** to be able to open.

In the other side space area between the other sidewall **18a** of the framework **10** and the other outside panel **14b** of the outer case **14**, nothing exists. The front opening of the other side space area is covered with a not-shown second open/close cover **44** attached to the front end of the other outside

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panel **14b** to be able to open. The second open/close cover **44** is formed with a number of ventilation openings **44a**.

When a not-shown main switch of the transmitter is turned on, two airflow producing devices **30** of each of two airflow producing units **32a** and **32b** are also turned on. As a result, a current of air is produced in the inner space of the outer case **14** of the housing **12** from the ventilation openings **44a** of the second open/close cover **44** to the ventilation openings of the right side vertical section of the rear panel **14e** of the outer case **14**, through the side space area between the other sidewall **18b** of the framework **10** and the other outside panel **14b** of the outer case **14**, the ventilation openings **24** of the other sidewall **18b** of the framework **10**, the ventilation openings **24** of the one sidewall **18a** (particularly, the four ventilation openings **24** corresponding to the four airflow producing devices **30** of the two airflow producing units **32a** and **32b** corresponding to the two upper and lower chambers of the duct member **26**), the side space area between the one sidewall **18a** of the framework **10** and the one outside panel **14a** of the outer case **14**.

This current of air in the inner space of the outer case **14** is strong in the four ventilation openings **24** corresponding to the four airflow producing devices **30** of the two airflow producing units **32a** and **32b** corresponding to the two upper and lower chambers of the duct member **26**, and can efficiently discharge the heat generated by the heat generating devices including the amplifier and held by the four shelf members **20** corresponding to the four ventilation openings **24**, to the outside space through the ventilation openings **16** of the right side vertical section of the rear panel **14e** of the outer case **14**.

Moreover, since two airflow producing devices **30** arranged in the back and forth direction are assigned to the two ventilation openings **24** corresponding to the two adjacent shelf members **20** in the sidewall **18a** of the framework **10**, even if one of two airflow producing devices **30** fails and stops, the other airflow producing device **30** can forcibly suck air through the two ventilation openings **24**. Therefore, the heat generated by the heat generating devices including an amplifier and supported by the two shelf members **20** corresponding to these two ventilating openings **24** can be efficiently discharged to the outside space through the ventilation openings **16** of the right side vertical section of the rear panel **14e** of the outer case **14**.

In addition, since the size of each airflow producing device **30** corresponds to the two ventilation openings **24** corresponding to the two adjacent shelf members **20**, its airflow producing capacity is large. Namely, its heat discharging capacity is high. Further, since these two airflow producing devices **30**, each having the above described size, are arranged in the back and forth direction to the corresponding two ventilation openings **24**, the height of the framework **10** can be compact.

For the maintenance of the two airflow producing devices **30** of each of the airflow producing units **32a** and **32b**, the not-shown first open/close cover covering the two airflow producing units **32a** and **32b** in the front opening of the outer case **14** of the housing **12** is opened to expose the grips **38a** and **38b** of the airflow producing units **32a** and **32b**, as shown in FIG. **1**.

Then, the grips **38a** and **38b** are pulled, so that the airflow producing units **32a** and **32b** are moved from the retracted position shown in FIG. **1** to the projecting forward position shown in FIG. **5** with respect to the duct member **26**. This facilitates the maintenance of the two airflow producing devices **30** of each of the airflow producing units **32a** and **32b**.

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Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

What is claimed is:

1. A housing apparatus for a heat generating device, comprising:

a housing which has a height, a width, and a depth, and which includes a plurality of sidewalls arranged in a lateral direction along the width to separate from each other, and a plurality of shelf members placed at a plurality of positions along the sidewalls between the sidewalls to support a plurality of devices including at least one heat generating device, the plurality of positions being arranged in a height direction along the height, and each sidewall having a plurality of ventilation openings arranged in the height direction to correspond to the devices held by the shelf members;

a duct member which is provided on at least one outermost sidewall of the sidewalls of the housing, and which corresponds to at least two ventilation openings located adjacent to each other in the height direction in the at least one outermost sidewall, the duct member including an airflow guide plate providing at least two adjacent airflow guide paths corresponding to the at least two adjacent ventilation openings, the at least two adjacent airflow guide paths communicating with the at least two adjacent ventilation openings respectively; and

an airflow producing unit which is provided on the duct member and which includes at least two airflow producing devices performing one of supplying outside air into the inside of the housing and evacuating the inside air from the housing through the at least two adjacent ventilation openings corresponding thereto;

wherein the at least two airflow producing devices of the airflow producing unit are arranged in the back and forth direction;

each of the at least two airflow producing devices arranged in the back and forth direction faces the at least two adjacent ventilation openings located adjacent to each other in the height direction and corresponding to the at least two airflow producing devices through the duct member, the airflow guide plate being located between the at least two airflow producing devices and the at least two adjacent ventilation openings located adjacent to each other in the height direction; and

each airflow producing device performs one of supplying outside air to the inside of the housing and evacuating the inside air from the housing, through each airflow guide path corresponding to the respective airflow producing device and through each of the at least two adjacent ventilation openings corresponding to the respective airflow producing device wherein when evacuating the inside air from the housing, the outlets of the at least two adjacent airflow guide paths are arranged in a back and forth direction along the depth.

2. The housing apparatus for a heat generating device according to claim **1**, wherein the airflow producing device includes an axial fan.

3. The housing apparatus for a heat generating device according to claim **1**, wherein the heat generating device

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includes an amplifier, and the devices including the heat generating device provide a transmitter of a communication device.

4. The housing apparatus for a heat generating device according to claim 1, wherein:

the ventilation openings in the at least one outermost sidewall provide plural combinations each of which includes the at least two adjacent ventilation openings, and

the duct member provided with the airflow producing unit including the at least two airflow producing devices is provided on the at least one outermost sidewall of the sidewalls of the housing to correspond to each combination of the at least two adjacent ventilation openings.

5. The housing apparatus for a heat generating device according to claim 1, wherein the number of the ventilation

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openings corresponding to the duct member in the outermost sidewall of the housing, the number of the airflow producing devices provided in the duct member, and the number of the airflow guide paths provided by the airflow guide plate included in the duct member are equal.

6. The housing apparatus for a heat generating device according to claim 1, wherein one of the ventilation openings is formed at each of the plurality of positions in the height direction in the at least one outermost sidewall of the housing, each ventilation opening is long and narrow in the back and forth direction, and each airflow producing device faces one of a forward half and a back half of each ventilation opening corresponding to the respective airflow producing device.

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